Accident Analysis and Prevention 47 (2012) 16–23

Contents lists available at SciVerse ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Relationship between types of head injury and age of pedestrian

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ARTICLE INFO

Article history:
Received 5 April 2011
Received in revised form
21 November 2011
Accepted 8 January 2012

Keywords:
Road safety
Pedestrian
Traumatic brain injury
Risk
Age
Traffic accident

ABSTRACT

This paper explores the relationship between age and the different types of head injury received by pedestrians in traffic accidents with cars. The analysis is based on information collected by hospitals in England, and is supported by in-depth case examples. The principle result is that the risk of intracranial injury increases with age, whilst the risk of fracture to the head or facial bones remains relatively constant. This agrees with previous findings for other groups of casualties, which have reported that that the decrease in brain size leads to an increase in the relative motion of the skull and brain in an impact, with a corresponding increase in the risk of traumatic brain injury. Intracranial injuries have also been found to place the greatest burden on hospitals, which may have implications on automotive design if prevention of these injuries is to be prioritised over fractures of the skull.

1. Introduction

This paper uses information collected by hospitals in England and in-depth accident data, to explore the relationship between age and the occurrence of traumatic brain injury (TBI) for pedestrians in traffic accidents with cars.

Motor vehicle accidents are the leading cause of TBI in the general population. Dawodu (2003) found that motor vehicle accidents account for approximately 50% of all TBIs amongst whites in the United States. Whilst some of these brain injuries may appear to be quite minor in severity, according to Jennet (1989) about 1 in 100 patients admitted to hospital with a head injury will be left with disability of one kind or another.

The World Health Organisation (2009) estimates that more than 1.2 million people die in traffic accidents every year and 50 million people are injured worldwide. A large proportion of these casualties are pedestrians: in low and middle-income countries over half of deaths are vulnerable road users, including pedestrians. Pedestrians are particularly vulnerable to serious head trauma. Of over 72,000 pedestrians admitted to hospital from 1998 to 2007 in England, the most serious injury was most frequently to the head; and of these, intracranial injury was the most frequent specific injury type (Richards et al., 2009b).

1.1. Relationship between TBI and age

Based on a survey of head injured patients admitted to the Neurosurgical Department at Karolinska Hospital, Viano et al. (1997) observed that, "The fraction of patients with poor neurologic outcome increases with age, reflecting a reduced injury tolerance and recovery in older patients". Also, according to Goldstein et al. (1999), older adults sustaining mild and moderate closed head injuries showed cognitive and behavioural changes, according to their significant others, that were similar to those seen in young adults following more severe head injury.

A skull–brain finite element model of the human head was developed by Claessens et al. (1997) using digital CT and MRI data. A parametric study was used by these authors to assess the importance of the level of geometric detail to which the head components are modelled and the skull–brain interface conditions on intracranial pressures and stresses during a head impact event. Claessens et al. concluded that the relative motion at the skull–brain interface had a larger influence on the intracranial pressures and stresses than detailed modelling of the structures of the intracranial contents.

It is known that brain volume, and in particular volume of grey matter decreases with age, whilst at the same time, the volume of cerebrospinal fluid increases (Smith et al., 2007). In a review of major trauma in the elderly, Sarkar (2009) noted physiological changes in the elderly, compared with younger people. Amongst these physiological changes Sarkar cites, "reduced brain mass and adherent dura to skull". According to Sarkar, this leads to subdural haemorrhages being predominant over extradural haemorrhages; noting that subdural haematomas can exist with relatively minimal

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0001-4575/$ – see front matter
doi:10.1016/j.aap.2012.01.009